RESEARCH DEPARTMENT

ACOUSTIC TESTS AT BROADCASTING HOUSE, GLASGOW

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SUMMARY

Building modifications in the studio area comprising studios 4, 5, 6, 7 and 8 on the third floor of Broadcasting House, Glasgow, are under consideration. The primary aim of the measurements described in this report was to determine the sound insulation of the roof of these areas, and to consider whether it can be increased sufficiently to exclude aircraft noise from the studios. Additional measurements relevant to these modifications were also carried out.

1. INTRODUCTION

Broadcasting House lies directly beneath the instrument approach path to Renfrew Airport under the most common wind conditions. Aircraft may therefore fly over the area at a height apparently not greater than 1,000 ft (305 m) at all times of the day.

The airport facilities for Glasgow are shortly to be moved to Abbotsinch which, because of its greater distance, will increase the height of the aircraft over Broadcasting House; the move will, however, permit the landing of larger aircraft and the possibility of higher noise levels in the future will have to be considered.

With this problem in mind the roof of the new television studio was constructed with two skins spaced approximately 5 ft apart. The resulting average sound insulation is between 83 and 86 dB and aircraft noise is not audible or measurable in the studio. Since modifications are being considered in the area comprising studios 4, 5, 6, 7 and 8 to improve the ease of operation, we were requested to obtain sufficient information to decide whether aircraft noise could be excluded from these studios also.

2. MEASUREMENTS IN STUDIOS 4, 5, 6, 7 AND 8

2.1. General Description

The area at present comprising studios 4, 5, 6, 8 and a dramatic production room (D.P.R.) Studio 7 is situated on a mezzanine floor above the third floor. The studios are built on three sides of an open-area, the fourth side being an outside wall of Studio 1 (Fig. 1); Studios 5, 6 and 7 are protected on this side by the artistes' lounge. With the exception of No. 8, the studios have outside walls, but these are of massive construction. The pitched roof is of slate over boards. The studio ceilings are of slotted hardboard backed by scrim bags of porous material.

The building works proposed include the incorporation of the effects store into Studio 5, the modification of Studio 6 to be a dead area attached to Studio 5 with a new observation window, the separation of the present D.P.R. Studio 7 to be the cubicle to Studio 4, and changes to the acoustic treatment in Studios 4 and 8.

2.2. Measurement of Roof Insulation

It was proposed to determine the sound insulation of the roof structure by measurement of aircraft noise levels inside and outside the studios. Twin-track recordings were therefore made with a calibrated microphone in a wind shield on the roof of this section of the building, and a second calibrated microphone inside the building which was moved from studio to studio. Recordings of road traffic noise were made under normal traffic conditions and in addition in each studio the passage of at least one aircraft was recorded. Presumably because of a variation in the wind direction the aircraft did not fly directly over Broadcasting House, but were slightly to the northwest of it. This has meant that in some of the studios the aircraft noise is masked at some frequencies by ventilation noise.

The recordings have been analysed through octave band pass filters and the results plotted on a high speed level recorder. For each event considered, the insulation of the roof is determined as the sound level difference between the levels measured on the inside and outside microphones. At least three events have been analysed for each studio. If it seemed from the results that the particular noise being analysed was masked by another continuous noise and that the corresponding value of sound level difference would be lower than expected, the result has been neglected in deriving a mean insulation for this studio. The results are shown in Fig. 2.

An additional measurement was made for Studio 5 using a revolver which was fired on the roof. The mean sound level differences between a single pair of microphone positions for four shots fired at slightly different positions are also shown for comparison in Fig. 2. It has been demonstrated in the course of previous measurements on the roof of the television studios that good agreement could be obtained between measurements with a revolver or aircraft noise as a source. Unfortunately in the present case the sound level differences are somewhat greater than those found with an aircraft as a source of noise. This discrepancy may illustrate the existence of a path of low sound insulation under the eaves. The revolver was fired on the roof above the artistes' lounge. The eaves lie on the other side of the roof and were therefore protected from the noise of the revolver by the intervening ridge; no such protection would exist for aircraft noise. Drawings supplied by Building Department suggest a lighter construction under the eaves than elsewhere.

The measured sound pressure levels from aircraft are plotted in Fig. 3. As has been mentioned, the aircraft were not flying directly over Broadcasting House and the maximum possible levels were therefore not found on this occasion. Fig. 3 also contains results determined on a previous visit to Studio A Glasgow and estimated noise levels from heavier aircraft which may be expected to use Abbotsinch.[1] The aircraft are, in fact, approaching to land while over Broadcasting House, but may on occasion increase power from the engines in order to correct height or flight path. It seems probable, therefore, that on occasions sound pressure levels in the region of 95 dB will be found in all octave bands up to that centred on 1 kc/s.

Since the studios are principally drama studios, the relevant noise criterion to be met is curve 'C' on drawing RA.17936. This curve is reproduced on Fig. 4. The values of sound level difference required to reduce the aircraft noise to conformity with curve 'C' are plotted in the upper curve in Fig. 2 and the improvement required in roof insulation will be seen to be of the order of 23 dB in each octave.

2.3. Improvement of Roof Insulation

It seems probable that a reasonable improvement in the insulation of the studio roofs could be made. It may be assumed that the reduction of sound level through the studio ceilings, which are of slotted hardboard and porous material, is small. With the considerable space which exists between the pitched roof and the studio ceiling, the sound level difference of the ceiling should be practically additive to that of the main roof. If, therefore, an additional skin of density about 3 lb/ft^2 (14·7 kg/m^2) were constructed over the ceiling joists and if absorptive treatment were introduced into the cavity between the skin and the roof, a reduction of the order required should be obtained. Such a skin might consist of 2 in. (50 mm) timber or 2 in. (50 mm) woodwool plastered on one side.

It is not clear by what means the section of roof at eaves height is insulated from the outside world. While it seems probable that this constitutes a path flanking the board and slate roof, there is no reason to expect that it would in addition flank a new ceiling such as that described above. However, it may be worth considering a more substantial construction at this point.

It is probably not possible to increase very greatly the insulation provided by the board and slate roof, but the addition of an extra skin resiliently mounted below the roof timbers might reduce radiation into the roof space.

2.4. Noise from Ventilation Plant Room

Under the proposed scheme of modifications, the stair-well shown in Fig. 1 leading to the ventilation plant room is to be incorporated into the cubicle of Studio 5. An additional measurement was carried out with a microphone in this stair-well to find whether the insulation of aircraft noise entering through the plant room would be adequate. Any aircraft noise was, in fact, completely masked by plant noise, the spectrum of which is plotted in Fig. 4. Also shown for comparison is the appropriate sound level criterion curve (curve 'C' on drawing RA.17936) and it may be seen that a considerable reduction in noise level will be required. Since access to the plant area can be obtained by an alternative door it would seem advisable to brick up the doorway from this plant room. This should reduce the sound pressure levels sufficiently provided no great degree of coupling exists between the equipment and the structure of the building. If the plant noise is excluded there should be no danger of aircraft noise entering the cubicle by this path.

2.5. Insulation between Studio 6 and Studio 7

After the proposed modifications, Studio 6 will become a dead area associated with Studio 5, while Studio 7 will become the control cubicle to Studio 4. In order to increase the sound insulation between these two areas, the existing observation window will be bricked up, and we were asked to determine whether this single measure would supply adequate insulation between the two areas. Fig. 5 shows the measured sound level differences between these two studios, and for comparison the acceptable insulation between a studio and the cubicle to a different studio. It will be seen that below 250 c/s the insulation is inadequate.

Measurements close to the observation window were carried out by a method proposed by London.[2] The results by this method of measurement were compared with the sound reduction index calculated from the measured sound level differences. These measurements suggest that below 250 c/s the measured sound level differences are limited by transmission by a path flanking the window; above 250 c/s the measured values are attributable to the window itself. This is unfortunate since an increase in insulation is required at frequencies below 250 c/s. The wall between these two areas at studio level is apparently of great thickness and the spacing in the double glazed window appears to be of the order of 18 in. (540 mm). However, above the ceiling level the void has been divided by a brick wall, and it is possible that this may form a flanking path at low frequencies. If this wall is of sufficient thickness to make such a possibility unlikely then further, more complicated, measurements will have to be carried out to locate the flanking path.

3. MEASUREMENTS IN OTHER STUDIO AREAS

3.1. Television Continuity

Since our last visit to Glasgow, a Television Continuity suite had been completed, and the opportunity was taken to carry out acoustic measurements in this area. Fig. 6 shows the measured reverberation times together with the calculated values. The agreement at most frequencies is satisfactory.

Fig. 7 shows the noise levels and for comparison the criterion curve for noise levels in a television studio. It will be seen that the noise levels are far in excess of those permitted in such an area, and at all frequencies below 4 kc/s these levels are attributable to the ventilation system. In practice it is generally found necessary to switch off the ventilation before making announcements from Continuity. Although the window was double glazed, aircraft noise was audible on one occasion in Continuity; unfortunately the equipment was not available to make recordings at this time.

3.2. Ventilation Noise in Studio 'A'

The ventilation system in Studio 'A' has been modified to reduce its noise levels which were thought to have increased considerably since its installation. Noise which was undoubtedly due to the flapping of sealing tape within the ducts has been eliminated. The measured octave band noise levels are shown in Fig. 8 with the appropriate criterion curve for comparison. Also shown for comparison are the measurements made at the time of completion of this studio (curve labelled 1-4-64). It will be noted that in spite of the modifications the noise levels are still higher than the original measured values, and that both curves lie well above the criterion curve. These conclusions do not agree with those quoted originally since the studio was then considered to be acceptable. The change, however, is more apparent than real since all television studios are now taken to include some drama requirement, and for this reason a new criterion curve has been proposed. The studio was set for a large production at the time of these recent measurements, and some of the noise will be produced by air-flow around the sets.

3.3. Studio 'B'

The ventilation noise in Studio 'B' was also measured and the results are shown in Fig. 7. The noise levels are rather high at frequencies below 500 c/s but practically meet the curve above this frequency.

A further measurement of reverberation time was requested, and the results are shown in Fig. 9 compared with a measurement made in 1955 when the studio was first taken over by the Television Service. The reduction in reverberation time is probably attributable to a wooden cyclorama and heavy draped curtains around the studio. The design figure for a television studio of this volume would be about 0·35 sec and it would appear that some additional treatment, particularly at low frequencies, would be useful.

The curved shape of the cyclorama is such that focussing effects in the corners of the studio appear inevitable. Difficulties with microphone balancing are reported by the sound staff but they are associated more with one side of the studio than with the other. There is no obvious reason for such a difference since the cyclorama is symmetrical at the corners. It would obviously be preferable for such a cyclorama to be acoustically transparent or

absorbent to prevent the danger of reflections occurring.

Many long rings were heard from the lighting fittings which in such a small studio are bound to be close to the loudspeakers and microphones. No complaints, however, are reported from the operational staff.

Measurements were made of the sound insulation provided by the scenery doors and the sound level differences are plotted in Fig. 10. In order to eliminate the possibility of interference with the programme in Studio 'A', it was necessary to make the measurements using the loudspeaker inside Studio 'B' rather than in the corridor outside, which would have been preferable. The "receiving side" microphone positions were maintained reasonably close to the doors being measured in view of the large size and unknown reverberation characteristics of the corridor and no correction to derive sound reduction indices is possible. The average insulation (125 c/s to 2·8 kc/s) is 40 dB. The continued rise in values at high frequencies suggests that the seals are operating satisfactorily. The fact that the central portion of the curve shows no steady rise with frequency in the range 350 c/s - 1·4 kc/s suggests the existence of one or more "coincidence" regions.

Comparison of these results with previous figures measured on similar doors at Television Centre shows a marked improvement below 500 c/s, particularly the absence of a serious minimum which previously has occurred at 125 c/s or 250 c/s.

4. REFERENCES

1. Research Department Report in preparation.

2. LONDON, A. 1941. Methods for determining sound transmission loss in the field. *J. Res. natn. Bur. Stand.* 1941, **26**, 5, pp. 419 - 453.

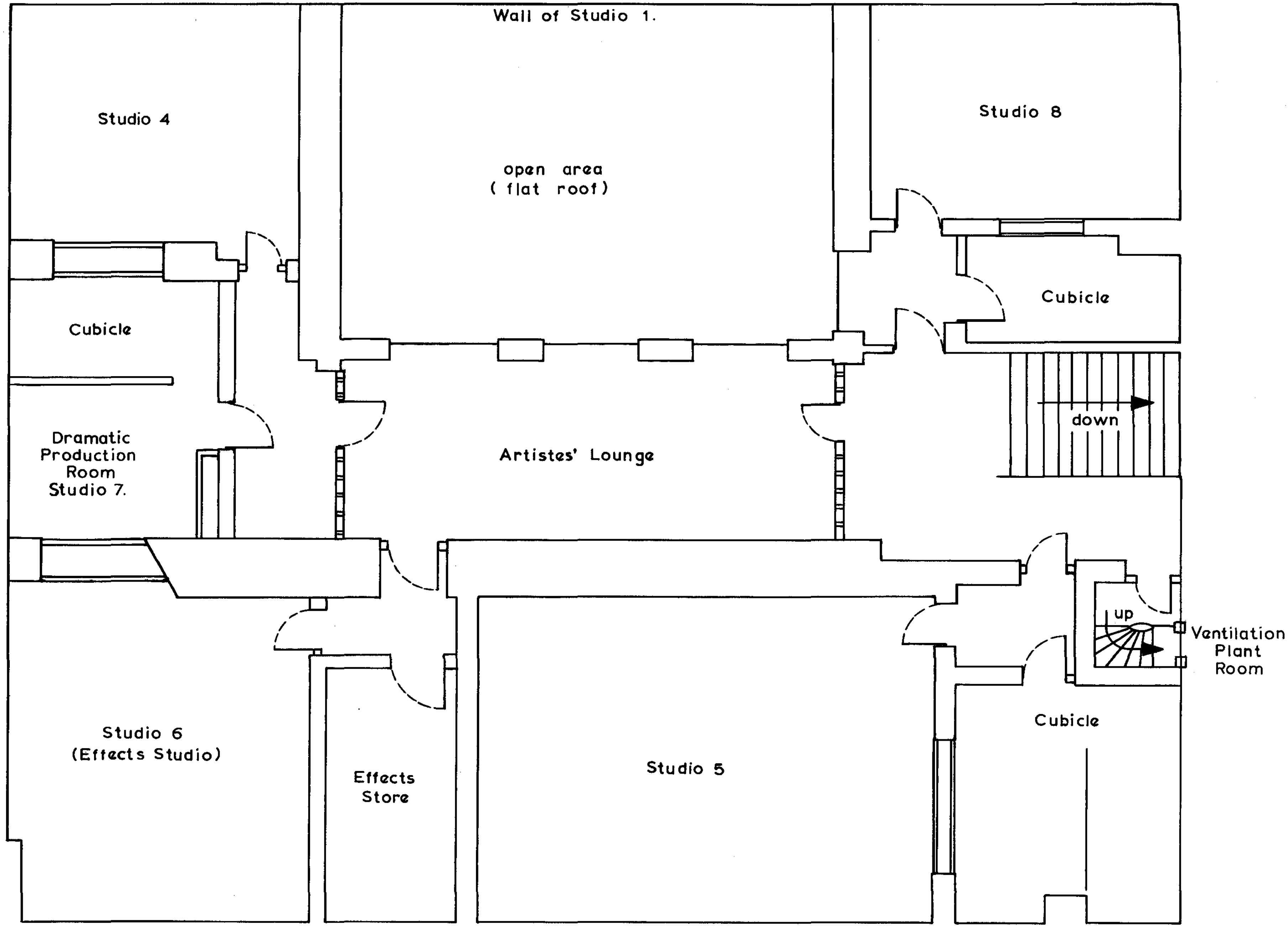

Fig. 1 Plan of Drama Suite

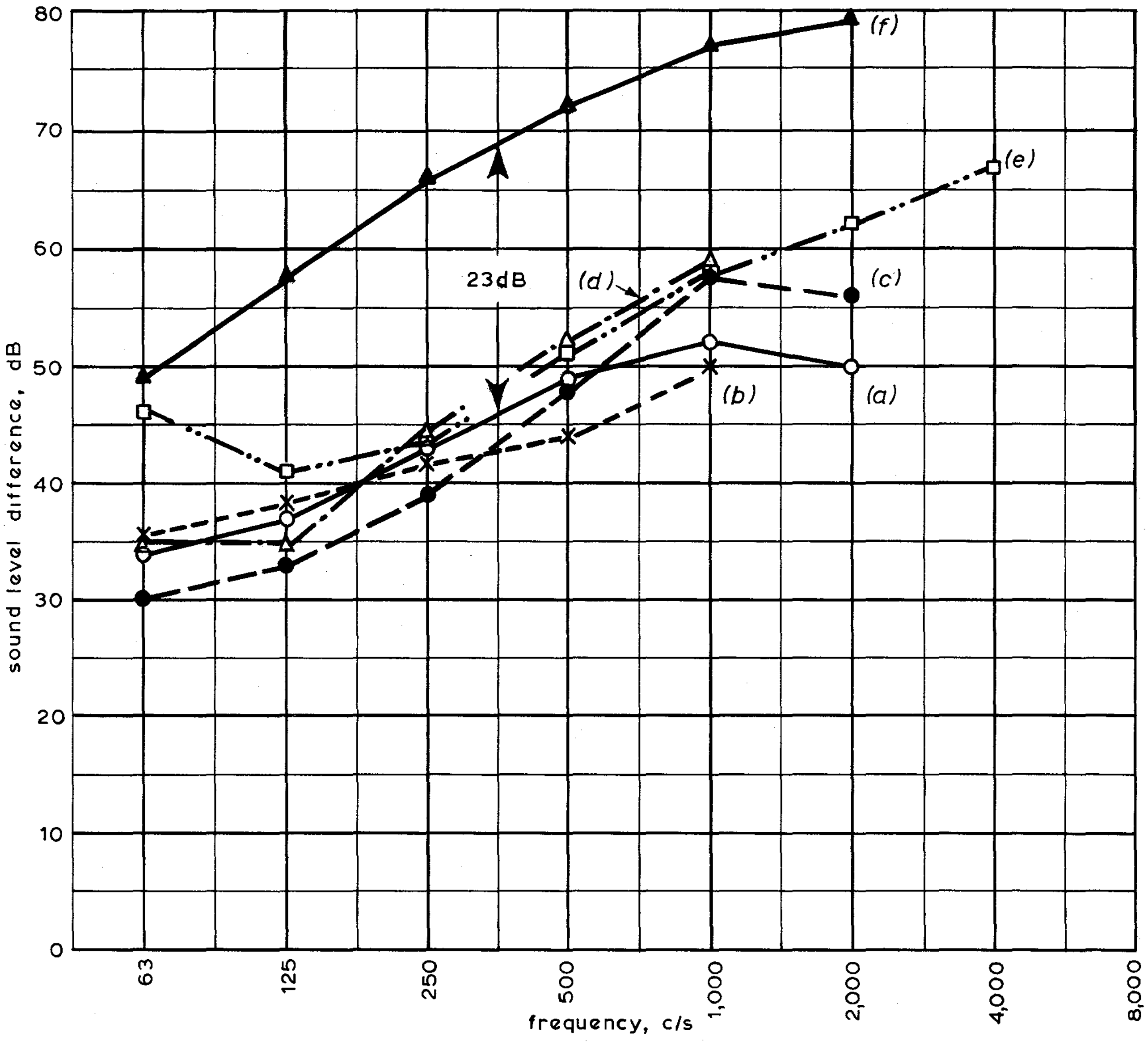

Fig. 2 Sound level differences of studio roofs.

(a) Studio 4
(b) Studio 5
(c) Studio 6
(d) Studio 8
} Aircraft noise source

(e) Studio 5. revolver source
(f) Insulation required to eliminate aircraft noise.

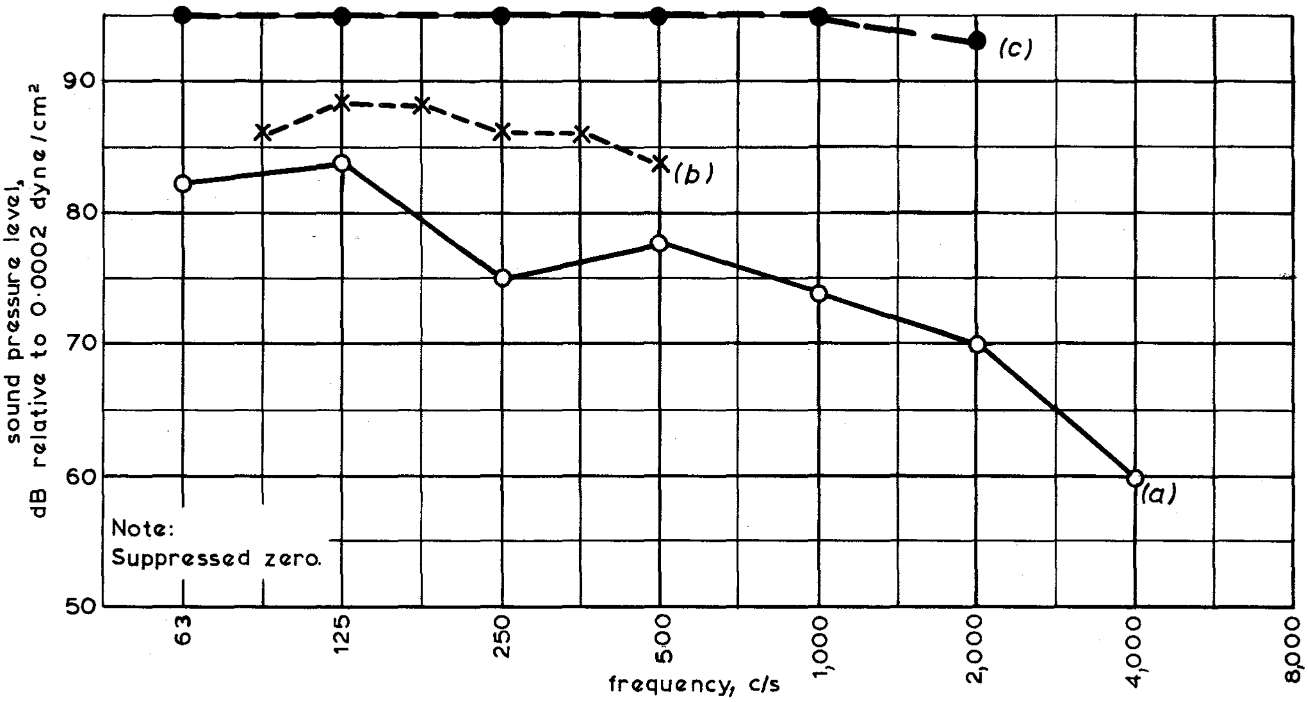

Fig. 3 Aircraft noise levels on roof.

(a) November, 1965 (r.m.s. measurements) *(b)* July, 1964 (peak measurements) *(c)* Expected noise level (r.m.s)

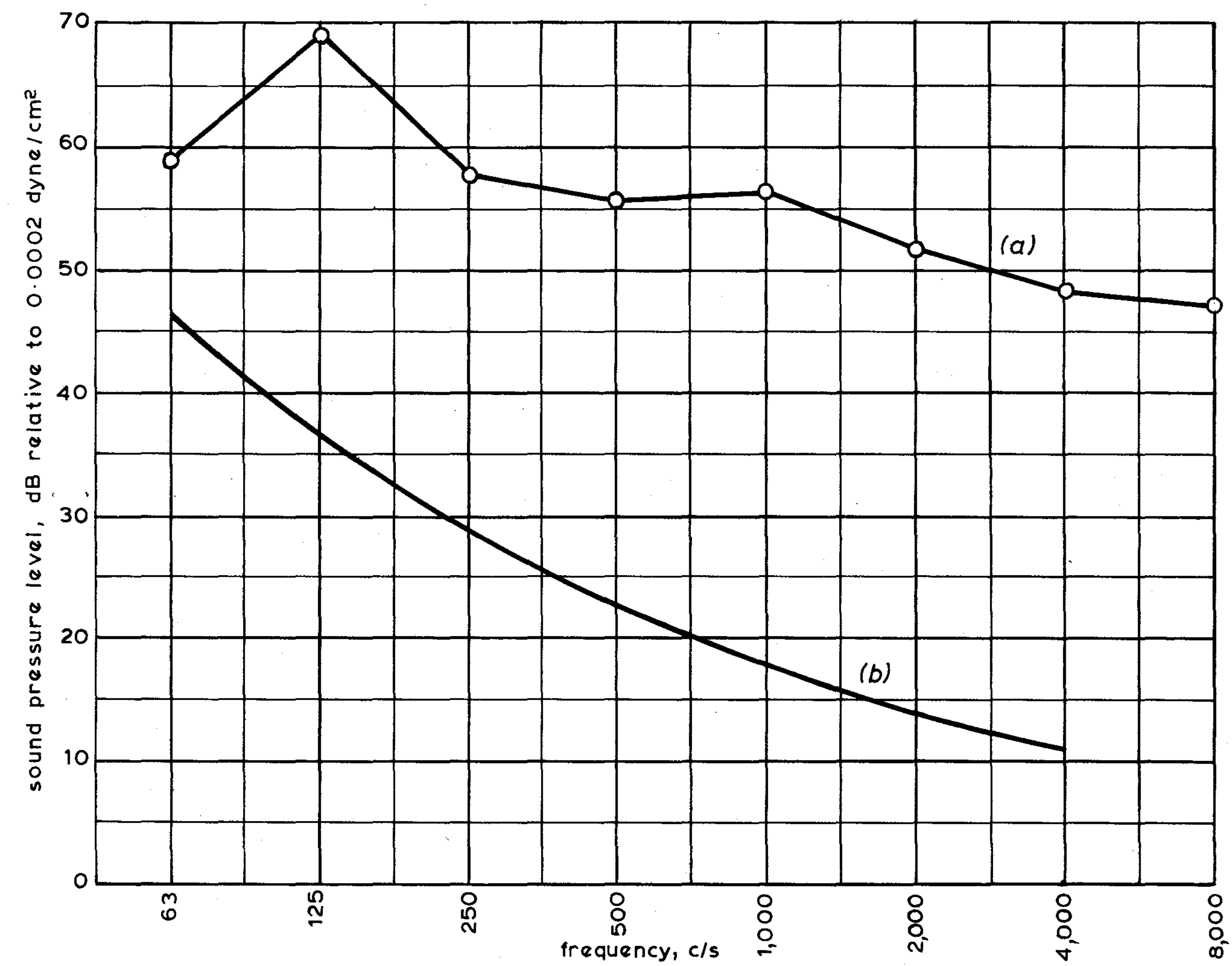

Fig. 4 Noise levels in stairwell from ventilation plant.

(a) Plant noise *(b)* Drama studio noise criterion curve.

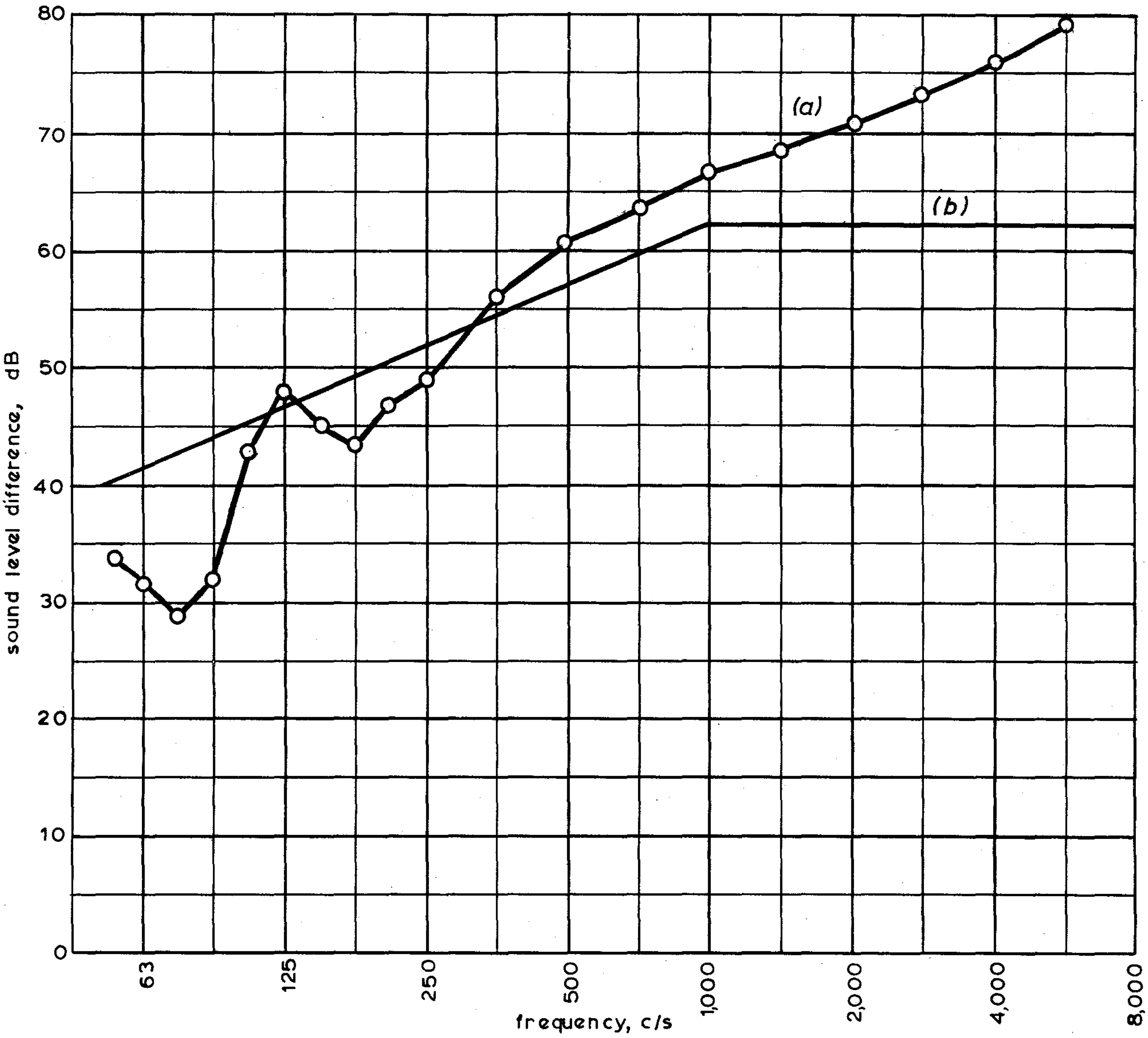

Fig. 5 Sound level differences from Studio 7 to Studio 6 compared with appropriate criterion curve.

(a) Sound level differences from Studio 7 to Studio 6. *(b)* Criterion curve.

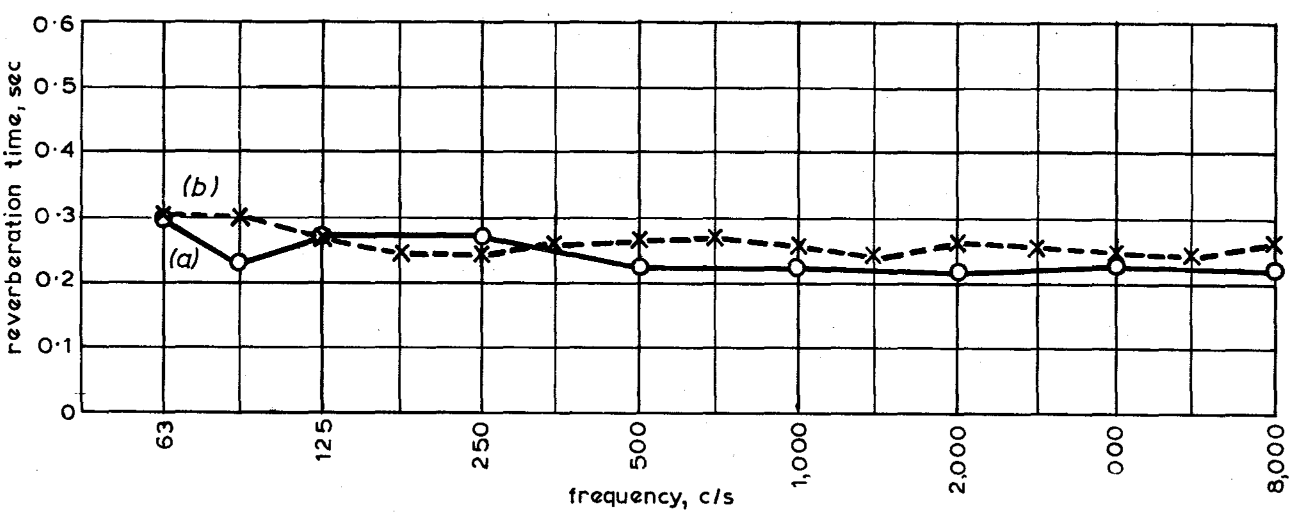

Fig. 6 Reverberation time of television continuity.

(a) Calculated *(b)* Measured.

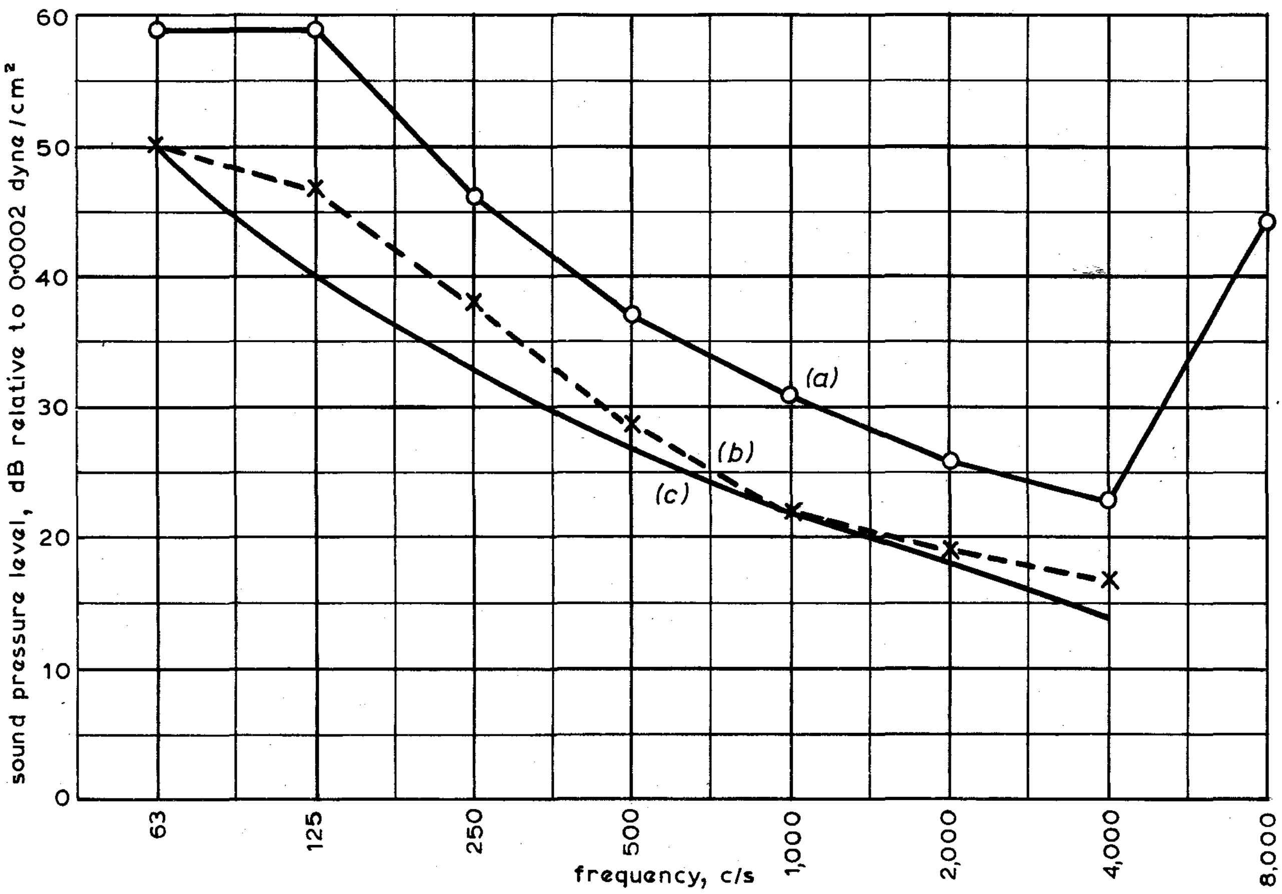

Fig. 7 Background noise levels in television areas.

(a) Television continuity. (b) Studio B. (c) Criterion curve (television studios)

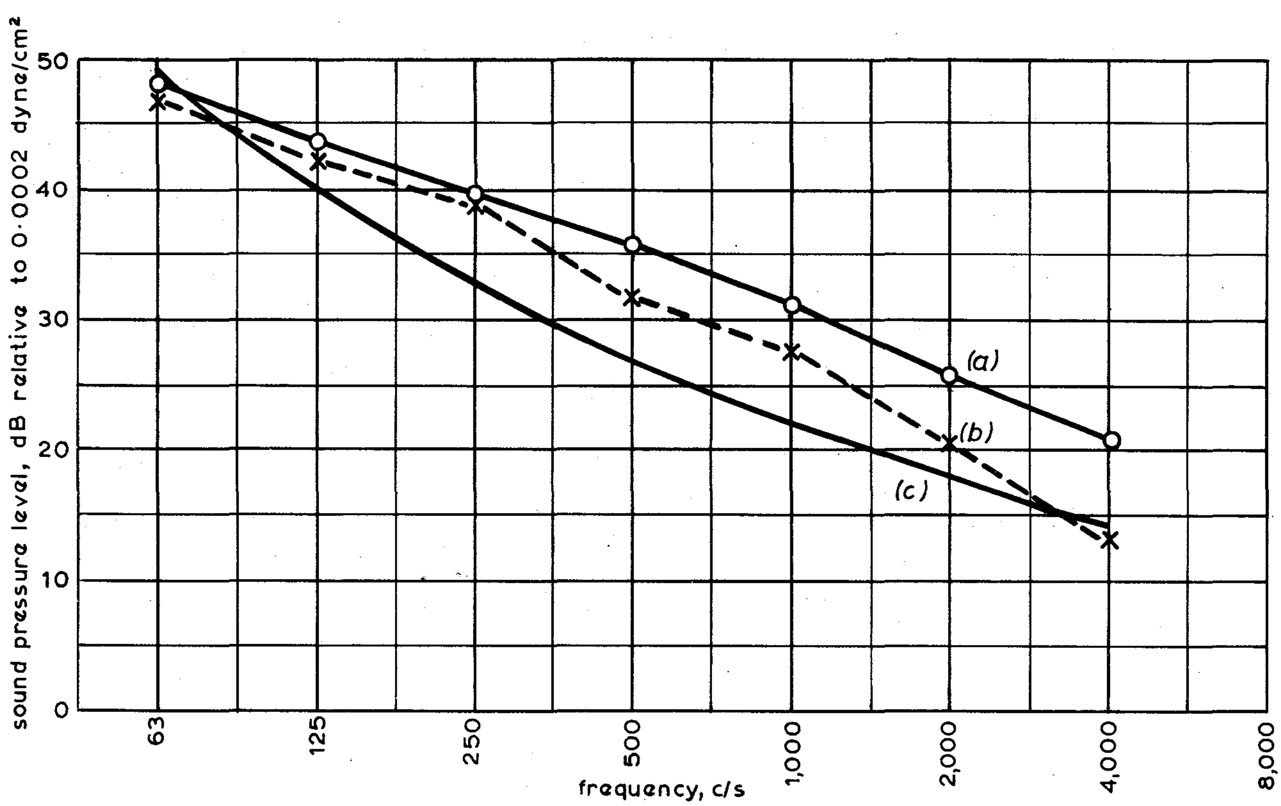

Fig. 8 Ventilation noise levels in Studio A.

(a) 22·11·65. (b) 1·4·64. (c) Criterion curve (television studios)

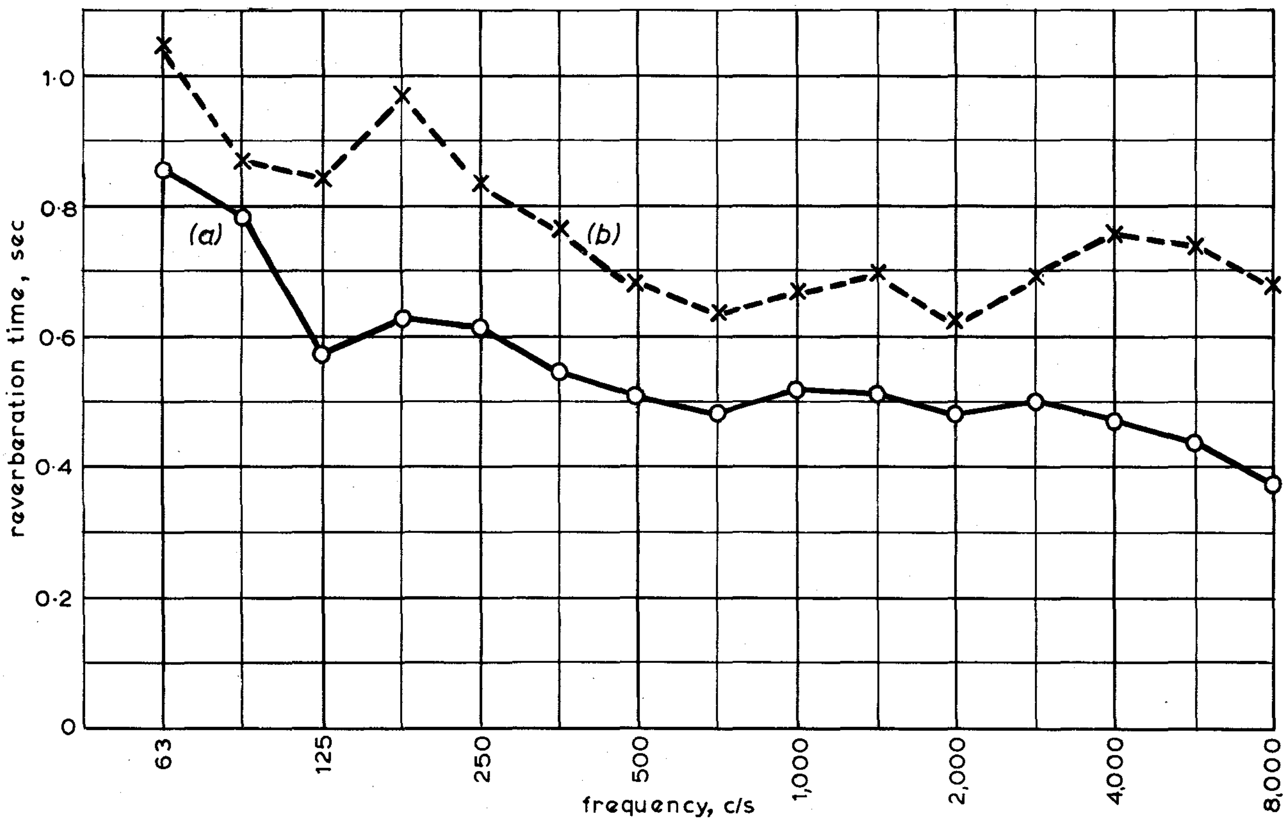

Fig. 9 Reverberation times of Studio B.
(a) 22·11·65. *(b)* 27·11·55.

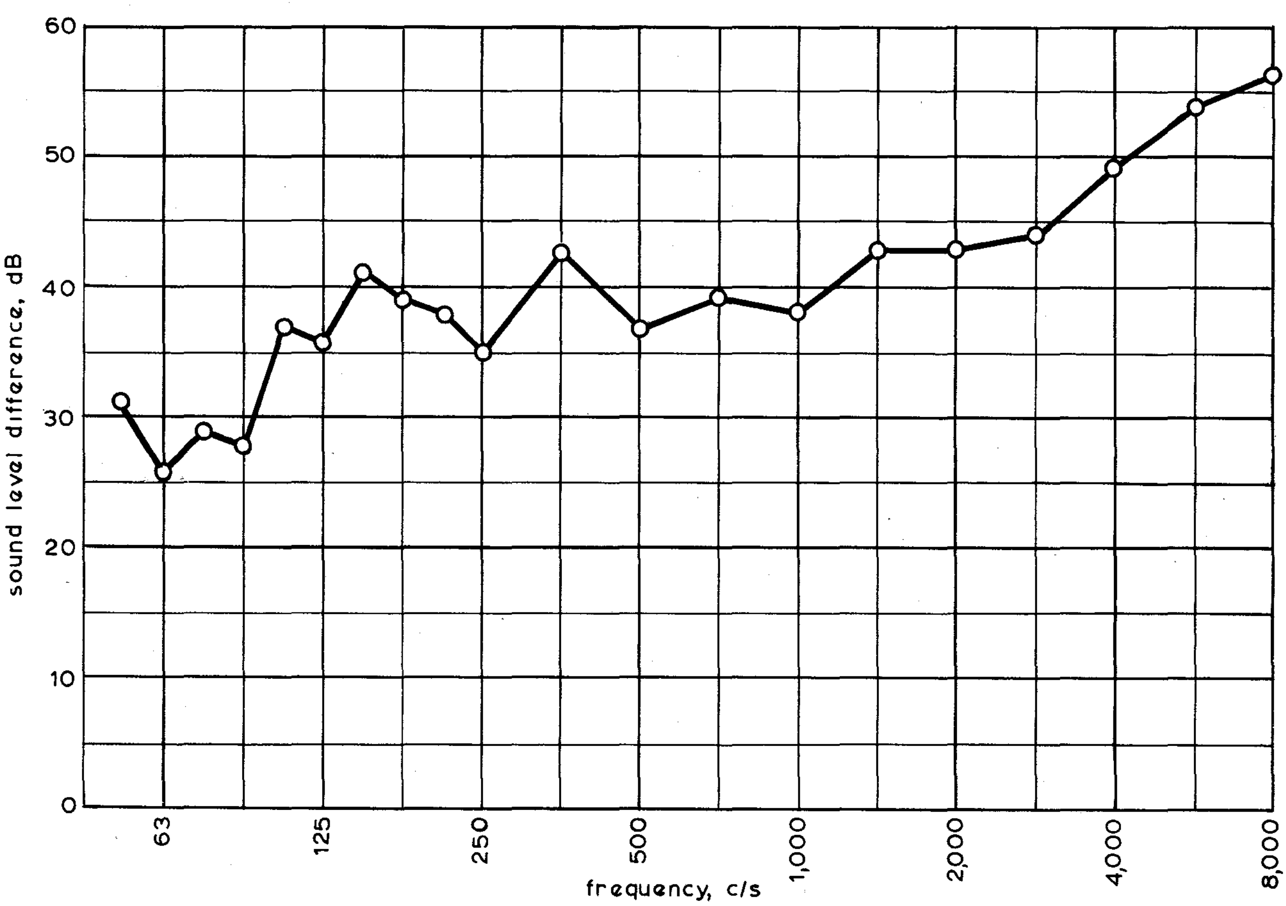

Fig. 10 Sound level differences through Studio B scenery doors.

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